3.6 Water Quality Study Plan

This study is designed to provide information regarding overall water quality in the vicinity of the Sacramento Municipal Utility District's Upper American River Project (UARP) and Pacific Gas and Electric Company's Chili Bar Project (projects), identify potential water quality problems related to the projects, and where the projects can control such factors, develop resource measures for the protection, mitigation and enhancement of water quality, Basic in situ water quality information will be gathered in projects reservoirs and in bypassed stream reaches to evaluate general aquatic ecosystem conditions. Under this study plan, water quality constituents will be sampled at times and in locations that may best identify water quality problems (Triage Sampling), and where problems are identified, follow-up investigations will proceed immediately and to the extent needed to clearly identify the problem and potential resource measures (Contingency Sampling). Some immediate Contingency Sampling activities are identified in this plan, but the full extent of Contingency Sampling cannot be identified until a specific problem is identified and an appropriate course of action determined by the Aquatics TWG. For instance, if warranted, Contingency Sampling may include multi-season or multi-year sampling. In addition to water column analysis, the potential for metals within projects waters to bioaccumulate through the aquatic food chain will be evaluated using fish tissue analysis in representative reservoirs. The Licensees recognize that the sampling program described in this Water Quality Study Plan could ultimately be as broad or broader in scope than the May 3, 2002 program discussed with the resource agencies, and are fully committed to implementing such a program if warranted.

3.6.1 <u>Pertinent Issue Questions</u>

The Water Quality Study Plan addresses the following Aquatic/Water Issue Questions:

Is operation of the Project protective of Basin Plan Designated beneficial uses?

- 39. How does the Project affect water quality (e.g. turbidity) and sedimentation, specifically at Slab Creek Reservoir, as operation of this reservoir affects sediment transport into Chili Bar Reservoir? How can we manage that impact if it exists? What are the historic events that have affected sedimentation?
- 41. Do the waters below the Project reservoirs meet the water quality objectives of the Basin Plan? How can the Project be managed to help meet them?
- 45 What type of long-term sediment and water quality strategies, operational practices and maintenance strategies exist?
- 46. Do the waters within the reservoirs and the diverted reaches adequately protect all designated beneficial uses?
- 47. Identify the Project-related pollution events that may have occurred in the watershed.
- 55. What are the (Project induced) effects of recreation (including on water and upslope activities) on water quality in the reservoirs and stream reaches (e.g. dispersed recreation and outhouses)?
- 60. What is the location of all spoil piles within the Project area and what are the effects on water quality?

Note that Issue Questions 39 and 45 as they relate to sediment are addressed in the Channel Morphology Study Plan, and Issue Questions 55 and 60 as they relate to upslope Project facilities, including spoil piles, are addressed in the Project Sources of Sediment Study Plan. Water temperature in both streams and reservoirs as well as pH, dissolved oxygen and conductivity in reservoirs are addressed in detail in the Water Temperature Study Plan and are included in this study to the extent that concurrent sampling will take place along with dependent constituents.

3.6.2 Background

Attachment 1 provides an overview of water quality constituents that are of primary interest in this study. Included in Attachment 1 for each constituent is a discussion of why it is important and sampling periods that may best represent seasons when the constituent would appear within the water column. Samples will be collected in those periods shown in Attachment 1 and described below. Initial water quality screening efforts will incorporate the concept of seasonality and will apply a general sampling approach that brackets projects-affected stream reaches and selectively samples impounded waters. However, because historical data collected on the South Fork Silver Creek below Ice House Reservoir and on Silver Creek below Union Valley Reservoir during dam construction (1959-

1961), and on the South Fork of the American River upstream of and just downstream of Slab Creek Reservoir (1992) during dredging of the reservoir may indicate that elevated levels of trace metals within the watershed (including Aluminum, Arsenic, Cadmium, Copper, Iron, Lead, Manganese, Mercury, Selenium, Silver, and Zinc) occurred during those periods, initial sampling efforts will include a focus on metals. To strengthen data collected in the initial triage approach to water column sampling and to determine potential bioaccumulation of metals within the aquatic food chain, fish tissues will be analyzed.

3.6.3 <u>Study Objectives</u>

The study objectives are to:

- Characterize water quality under current Project operations by directly monitor water quality and using historical information as well as information from the Water Temperature, Channel Morphology, Project Sources of Sediment and Aquatic Bioassessment studies, among other studies.
- Determine if Basin Plan water quality objectives (and other applicable water quality criteria) are met and
 assess whether Basin Plan designated beneficial uses are protected. Note that the SWRCB will ultimately
 determine if Basin Plan designated beneficial uses are protected during the 401 process.
- 3. Identify any project-controllable resource measures for the protection, mitigation and enhancement of water quality.

3.6.4 <u>Study Area and Sampling Locations</u>

The study area includes all reservoirs associated with the projects (Rubicon, Rockbound, Buck Island, Loon Lake, Gerle Creek, Ice House, Union Valley, Junction, Camino, Brush Creek, Slab Creek and Chili Bar) excluding Robbs Peak Forebay due to its small size (30 acre-feet), and all stream reaches identified by the Aquatic TWG and Plenary Group (Rubicon Dam, Rockbound Dam, Buck Island Dam, Rubicon Tunnel Outlet, Loon Lake Dam, Gerle Creek Dam, Robbs Peak Dam, Ice House Dam, Junction Dam, Camino Dam, South Fork American, Brush Creek Dam, Slab Creek Dam and the Reach below Chili Bar Dam). The study area also includes, to the extent necessary, tributary inflows into the reservoirs and reaches. Sampling locations are listed in Attachment 2.

3.6.5 <u>Information Needed From Other Studies</u>

Information needed from other UARP relicensing studies includes:

- 1. Location of Project-related recreation facilities from the UARP Relicensing recreation studies
- 2. Results of the Water Temperature Study to assess compliance with the Basin Plan water temperature standards
- 3. Results of the Channel Morphology and Project Sources of Sediment studies
- 4. Flow data from the Hydrology Study
- 5. Results of the Aquatic Bioassessment Study to corroborate the results of the Water Quality Study
- 6. Results from other resource studies to assess level of protection provided for Basin Plan Designated Beneficial Uses

The output of this Water Quality study may be used in other studies to assist in determining the overall health of the aquatic ecosystem.

Study Methods And Schedule

The study methods will include the following subtasks:

3.6.6

Gather Historic Information: Interviews will be done with SMUD Operations staff, ENF, SWRCB, RWQCB and CDFG staff and others to identify any Project-related historic pollution events, and any water quality data routinely collected by SMUD (such as turbidity levels upstream and downstream of Slab Creek Reservoir) or others. Also, these interviews will help determine if there are any historical water quality data available other than what is reported in SMUD's Initial Information Package (SMUD 2001) and what has been discussed with the Aquatic TWG to date. Documentation of pollution events (i.e. reports of events and follow-up actions), potential affects of the projects, as well as other historical water quality data will be collected. An inventory shall be prepared of all historic pollution events identified and any mitigation actions taken, including reference sources and a companion map that presents locations of documented events and geographic expanse of known effects.

Water Quality Data Collection

<u>Laboratory Reporting:</u> The laboratory will provide for each constituent sample, the laboratory's current method detection limit, reporting limit, practical quantitation limit, and J-value as appropriate. The lab will attempt to obtain, and report at detection limits at or below the adjusted maximum regulatory criteria. (See glossary of terms included as Attachment 4)

Sample In situ Field Parameters: Basic water quality parameters, including temperature, dissolved oxygen, conductivity, and pH will be measured at all general sampling locations and specified bypassed stream reach stations (identified in Attachment 2) once each during the spring runoff, the summer low-flow period, the fall season, and following the first major rain event. Reservoir stations will include in situ profiles and stream stations will be sampled from the shoreline in moving flow with the sampler upstream of the meter. Turbidity and TSS will be analyzed in the laboratory.

<u>Sample Standard Water Quality Parameters</u>: Attachment 1 lists seasonal sampling periods for each constituent to be analyzed in the water quality screening effort. For planning purposes, sampling for the fall turnover season is expected to be conducted in 2002, first major rain event sampling will be conducted in November/December 2002, and the spring runoff sampling period will occur in April/May 2003. The summer low-flow sampling period will occur in August/early September 2003. The Licensees will sample once in each specified sampling period beginning with the summer low flow period in 2002. The constituents that will be sampled in each seasonal period are those that behave in a manner most likely to be represented during the designated sampling period(s) and those constituents required for analyzing standard constituents (indicated by an "X" in Attachment 1). Sampling for these constituents can be divided into two phases: Triage and Contingency.

a) Triage Sampling: Triage sampling is designed to screen for water quality problems associated with the projects. Water quality samples will be collected once immediately downstream of each projects facility, in each projects reservoir and in the major inflows to each reservoir (Attachment 2). It is expected that many of the water quality sampling locations will correspond to water temperature monitoring locations. Interested Aquatic TWG and Plenary Group Participants will be invited into the field to confirm the sampling locations before sampling locations are finalized. One sample will be taken from the riverbank in flowing water (sampler upstream) downstream of each project facility and in major inflows to each reservoir (Attachment 2). During the summer low flow period when the reservoirs may be stratified, water quality samples will be collected in the upper epilimnion and in the hypolimnion a few feet above the reservoir bottom. During the fall turnover, spring runoff and first major storm critical periods when the reservoirs are not stratified, one sample will be collected at a point approximately one-third the total depth below the surface. Timing of reservoir turnover will be determined by thermographic profiles in Loon Lake Reservoir (representing Rubicon, Rockbound, Buck Island, Gerle and Loon Lake reservoirs), Union Valley Reservoir (Junction and Union Valley reservoirs), and Slab Creek Reservoir (Brush Creek, Camino, Chili Bar and Slab Creek reservoirs),

> conducted at intervals no greater than once weekly beginning October 1 and continuing through fall turnover. For this purpose, turnover will assume to occur when the thermocline has broken down (less than 1°C change in temperature per meter). The Licensees will determine whether Loon Lake or Union Valley reservoir profiling will act as a surrogate for commencing Ice House Reservoir fall turnover sampling after the September reservoir water temperature profiling is done per the Water Temperature Study Plan. Timing of the first major rain event will be assessed by the Licensees, who will provide the criteria for this event to the Aquatic TWG. When each sample is collected, a multiparameter water analyzer will be used in situ to measure instantaneous water temperature, specific conductance, dissolved oxygen and pH At the same time, a grab sample will be collected in accordance with approved field sampling protocols. One Secchi depth measurement will be taken at each reservoir sampling location. Instruments will be calibrated prior to each field visit according to manufacturer's specifications. The date and time that the sample is collected, sampling site, jar number and other pertinent information will be recorded in the field for each sample, and the site will be located using a GPS unit. The grab sample jar will be labeled, preserved, stored and delivered to a State certified water quality laboratory and the contents analyzed using laboratory methods adequately sensitive to detect constituents at or below regulatory criteria levels. Where applicable, samples will be stored per laboratory standard operating procedures. Compliance with laboratory-approved storage procedures and with maximum holding periods allowed by lab method(s) used will be documented, and a chain-of-custody record will be maintained for each sample jar.

> Triage sampling for MTBE and TPH will only be conducted on the epilimnion and hypolimnion stations of Loon Lake, Ice House, and Union Valley reservoirs where significant boat traffic occurs. Concurrent with the timing of seasonal grab samples, fecal coliform screening samples will be collected in surface waters at near-shore locations proximal to reservoir recreation facilities and in diverted stream reaches identified as high-use dispersed recreation areas by the Recreation TWG (Attachment 5 (a), Bacteria Screening Stations - to be drafted and approved by Aquatic TWG, in consultation with Recreation TWG). For the fecal coliform screening purposes (as compared to the detailed coliform program described below), the SWRCB and Licensees agree that EPA Method 9221 may be used and that the samples may be held for up to 24 hours before processing. For the screening analysis, the TWG agreed to use E. coli analyses instead of fecal coliform, as long as it was used consistently throughout the screening effort. Additionally, the SWRCB and Licensees agree that no chlorophyll-a sampling will be collected during initial triage efforts. Instead, the Aquatic TWG will review the Secchi disk and nutrient data for each reservoir for indications of excessive production (eutrophication). If such indications occur (low Secchi depth reading as compared to other reservoirs and high nutrient concentrations), the Licensees in consultation with the Aquatic TWG will develop a contingency Sampling Plan that may include chlorophyll-a sampling, and phytoplankton/zooplankton sampling.

> For the grab samples, the lab will be instructed to immediately analyze the samples taken below the projects' facilities and in the reservoirs, including both epilimnion and hypolimnion samples collected during periods of reservoir stratification using the methods described in Attachment 3. The resulting data will be provided by email to the Aquatic TWG as soon as available from the lab. If SWRCB or other Aquatics TWG participants determine that data indicate that a problem might occur with one or more of the constituents (indicated by levels approaching regulatory numerical criteria thresholds, algae bloom noted in reservoirs or channel, or as otherwise identified by the Aquatic TWG), Contingency Sampling as described below will be initiated immediately.

b) Contingency Sampling: Contingency Sampling will focus on the specific water quality constituent(s) and areas where Triage Sampling data indicates a water quality problem might exist. It will include near-term and long-term activities to explore the problem. The near-term steps will include immediately directing the water quality lab to analyze the water quality samples taken from major inflows to the reservoirs for the constituent for which a problem is indicated. Because of the short laboratory holding times of certain constituents, SMUD and the laboratory will initiate special procedures to ensure that information is not lost due to expiration of the holding times. Constituents with short holding times include certain nutrients (e.g., Nitrate/Nitrite and Orthophosphate have 48

hour holding times) and TSS and TDS (7-day holding time). In these instances, the laboratory will be directed either to analyze for the specific constituents immediately upon arrival or to chemically preserve the samples for later analysis. Chemical preservation will only be performed in circumstances where the preservation does not influence the detection limit of the analytical technique. In addition, the Licensees will confer with the Aquatic TWG to identify any other locations (including downstream of the projects facilities and in tributaries to the reach) where additional samples should immediately be taken for the constituent. Some examples of where additional samples might be collected are listed in Attachment 2. The long-term activity will include developing a sampling program for the constituent at other times of the year or in multiple years, or in additional source or downstream locations if warranted based on the results of the near-term activities.

<u>Fecal Coliform Sampling Program</u>: A focused fecal coliform sampling effort will be conducted to demonstrate compliance with Basin Plan objectives requisite for protection of waters used for contact recreational activities. Samples will be taken at specified near-shore locations in the vicinity of reservoir recreation facilities and along diverted stream reaches known to be high dispersed-use areas (Attachment 5 (b), Fecal Coliform Program Sampling Stations — to be specified by Aquatics TWG, following consultation with the Recreation TWG). Samples will be collected no less than five times within a thirty-day period that includes either the Independence Day Holiday or the Labor Day Holiday.

Fish Tissue Analysis: Fish tissues will be sampled to assess potential bioaccumulation of metals in resident fish within specific reservoirs of the projects. Resident fish will be collected from locations within the Ice House, Union Valley, Slab Creek and Chili Bar Reservoirs, in accordance with CDFG Water Pollution Control Laboratory practices, and will be analyzed for Cadmium, Mercury, Arsenic, Nickel, Selenium, Chromium, Silver, Copper, Lead and Zinc, consistent with protocols of the SWRCB Toxic Substances Monitoring Program. Prior to initiating the tissue sampling effort, Licensees and their consultants shall provide to SWRCB staff and Aquatic TWG members a sampling plan that will meet the SWRCB and CDFG protocols.

OA/OC: All samples will be collected, handled and delivered to the lab consistent with specific EPA methods or other approved sampling/handling protocols including but not limited to Standard Methods for the Examination of Water and Wastewater. Appropriate QA/QC methods and documentation will be followed. Field QA/QC methods may somewhat vary by chemical constituents, but certain methods will be uniformly applied to all field sampling. Clean sampling techniques will be applied throughout the sampling effort. All sample bottles will be prepared by a California state-certified laboratory (ELAP). (Note that, due to the screening nature of the sampling, the Licensees and SWRCB agree that the single event fecal coliform/E. coli screening samples may be analyzed by a lab in Placerville, CA, if it is determined that the lab is reliable and even if it is not State certified.) The laboratory will prepare all sample bottles and, where necessary, place the appropriate amount and type of preservative in sample bottles. All field crew members collecting samples will be wearing gloves. All sample collection systems (e.g., Van dorn sampler) will be rinsed between sampling events with de-ionized water, and rinsed again with a portion of the sample water before filling of the sample jar. The labeled samples will be placed in closed, lightproof coolers filled with ice. Samples will delivered to the laboratory daily during sampling trips. The maximum holding times are indicated in Attachment 3. Iced samples are delivered to the laboratory within no more than 24 hours and typically within 12 hours of sample collection. In the case of mercury, EPA method 245.7 with a method detection limit of 10 parts per trillion (nanograms per liter) will be used as long as it is acceptable to the SWRCB. If this method is not acceptable to the SWRCB, a much more stringent field sampling regime will be followed in the future (EPA method 1631/1669). Quality control in the field will be assured by accurate and thoroughly completed sample labels, field sheets, chain of custody and sample log forms. Sample labels will include sample identification code, date, time, stream/lake name, sampling location, collector's name, sample type and preservative if applicable. Calibration of field instrumentation for field measurements of dissolved oxygen, temperature, pH, and conductivity will be done daily according to the manufacturer's instructions. Where appropriate, a two-point calibration will be applied. Hydrolabs deployed for continuous monitoring will be calibrated prior to initial deployment and at each data down loading interval (approximately every two weeks).

As discussed above, the result of the study will be presented to the Aquatic TWG as soon as available.

3.6.7 Analysis

All historical and newly gathered data will be summarized to characterize existing water quality conditions, and will be compared to regulatory criteria, standards and goals as identified by the SWRCB and members of the Aquatic TWG. As stated above, to assess compliance with Basin Plan water temperature and sediment objectives, the data from the Water Temperature, Channel Morphology, Project Sources of Sediment and Aquatic Bioassessment studies will be used. Further, the results of this study will be discussed with the results of the Hydrology Study.

3.6.8 Study Output

The Licensees and their consultants will provide data updates to the Aquatics TWG throughout the period of the water quality sampling program. A draft written water quality report will be presented to the Aquatics TWG for review and consideration no later than December of 2003. Based on one complete field season of data, and findings in the draft report, the SWRCB and members of the Aquatics TWG will determine the need for additional seasons of data collection and/or special constituent study. Final study output will be a written report that includes the issues addressed, objectives, study area including sampling locations, methods, laboratory reports and QA/QC, analysis, and results. A summary of results will be provided in tabloid format that shall include specific method detection limits for each constituent and analytical data reported. This report will include relevant graphs depicting the seasonal relationship between DO, temperature and pH at all locations. Additional graphs will be provided to more clearly demonstrate any changes in specific water quality parameters over time, depth, or longitudinal movement of flow through the system. Discussion appropriate to results and supportive of analyses and conclusions will be provided. All reports will be prepared in a format so that they can easily be incorporated into the SMUD's draft environmental assessment that will be submitted to FERC with Pacific Gas and Electric Company's Chili Bar license application.

3.6.9 <u>Preliminary Estimated Study Cost</u>

A cost estimate for this study will be developed after the Plenary Group has approved the study plan.

3.6.10 <u>TWG/Plenary Endorsement</u>

The Aquatic TWG approved this plan, as amended and with the understanding that the Licensees and SWRCB needed to resolve some items, on August 28, 2002 with the changes as noted. The participants at the meeting who said they could "live with" this study plan were USFS, CDFG, NMFS, PG&E and SMUD. None of the participants at the meeting said they could not "live with" this study plan. The Plenary Group approved this Study Plan on September 4, 2002, with the understanding that the Licensees and SWRCB would resolve their issues. The Plan was discussed again at the September 18, 2002 Aquatic TWG meeting and some modifications were made.

Since the SWRCB did not approve the study plan on August 28, 2002, the study plan was again discussed, revised and ultimately approved by the Aquatic TWG on December 2, 2002. The following TWG participants stated they could "live with" the study plan: USFS, PG&E, SWRCB, SMUD.

Given the changes in the text, the study plan was again presented to the Plenary Group on January 8, 2003 for final approval. The following participants stated they could "live with" the study plan: SWRCB, SMUD, USFS, PG&E, PCWA, GDPUD, Friends of El Dorado County, Camp Lotus, EID, and other participants. No one present at the meeting said they could not "live with" the study plan

3.6.11 <u>Literature Cited</u>

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Jordan, W.P. and Brown, R.J. 1993. American River Aquatic Sampling Report for November 1992. Prepared by Institute of Chemical Biology, University of San Francisco, for Sacramento Municipal Utility District.

Attachment 1 — Water Quality Sampling Periods Attachment 2 — Water Quality Sampling Locations Attachment 3 — Water Quality Analytical Methods

Attachment 4 - Glossary of Analytical Laboratory Terminology and Reporting Terms

Attachment 5 - Location of Fecal Coliform Sampling Stations (Developed by Aquatic TWG in consultation with the Recreation TWG)

Attachment 6 - Mercury in Tissue Sampling Protocol

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Water quality worksheet for the W Q Study Plan developed for relicensings of Sacramento Municipal Utility District's Upper American River Project and Pacific Gas and Electric Company's Chili Bar Project. (The column "What is it and why it is important" is provided as reference only.)

	t is it and why it is important" is pr		Sampling	Periods 1,3	
Constituent 4	What is It and Why is It Important?	Spring Runoff	Summer Low Flow	Fall Turn-over	First Major Rain
Water Temperature *	Temperature strongly influences aquatic biota. Increasing temperature results in lower dissolved oxygen concentrations. Temperature stratification in reservoirs can influence biological and chemical stratification in the reservoirs. Summer sampling is of most interest do to increased solar radiation and warmer water temperatures in riverine and reservoir reaches.	х	X	X	х
Dissolved Oxygen *	A measure of oxygen dissolved in water, measured as both ppm and saturation. In productive waters, large variation in dissolved oxygen can occur over a 24-hour period: Dissolved oxygen exhibits greatest fluctuations during periods of high photosynthetic activity (high DO) and high biotic activity and /or decomposition (low DO) in both riverine and reservoir reaches. Greatest fluctuations occur in late summer/early	9.3-11.1 mg/L X	X	x	X
pH *	fall. Logarithm of the reciprocal of the hydrogen ion concentration. This affects the solubility of metals in sediment and suspended material as well as toxicity of some compounds. A pH of 7 is neutral, a low pH is acidic, and a high pH is alkaline. Most aquatic biota require pH range of 6.5-8.5. 24-hour diurnal variations may exist most likely during late summer/early fall (similar to the dissolved oxygen diurnal patterns).	6.8-7.1 Units X	X	x	x
Turbidity	Measures inverse of water clarity, and affected by suspended and colloidal organic and inorganic matter. NTU scale is logarithmic. Elevated levels may cause gill abrasion in fish, reductions in incubation success, and impacts to benthic organisms.	<0.5-2 NTU's X	x	х	X
Hardness	Dependent primarily on amount of calcium and magnesium in water. Water with concentrations of 0 to 75 mg/l of calcium carbonate is considered "soft," and those between 150 and 300 are considered "hard." Good quality domestic water is usually less than 250 mg/l, and water above 500 mg/l encourages precipitation and scale. Often total alkalinity (see below) and hardness exhibit similar patterns. Regression models have been developed that have shown a positive linear relation between hardness and	4.5-7.2 mg/L X	X	х	х

			Sampling I	Periods 1,2	
Constituent 4	What is It and Why is It Important?	Spring Runoff	Summer Low Flow	Fall Turn-over	First Major Rain
Specific Conductance *	Capacity to conduct an electric current and quick measure of ion concentration, and indicates total dissolved matter (metals and nutrients) and alkalinity. Streams with mixed fish populations usually have specific conductance between 150 and 500 µmhos/cm. Sierra streams usually have low specific conductance; hence the need to augment ion concentration by salt	12-24 µhmos/cm X	x	X	х
Total Suspended Solids (TSS)	blocks when electrofishing. A measure of solids in water which can be removed by filtration. The origin of suspended matter may be man-made wastes or natural sources such as silt. Elevated TSS concentrations generally occur during peak runoff. Over time, amounts of inert solids in excess of 90 mg/l can be lethal to fish.	<5-45 mg/L X	x	х	X
Total Dissolved Solids (TDS)	A measure of the amount of material dissolved in water mostly inorganic salts-carbonates, bicarbonates, chlorides, sulfates, phosphates, nitrates, calcium, magnesium, manganese, sodium, potassium, and other cations. Most major ions are conservative; calcium, magnesium, carbonate levels can be affected by pH extremes. TDS will vary seasonally, generally based on flow regimes.	<10-21 mg/L X	X	X	
TOC.	TOC requires less sample and can be more reliable than BOD tests. Also, BOD typically used in systems that receive waste effluent.		X	х	
Nitrate/Nitrite	Nitrate result from normal decomposition of organic mater, and is a common form in which nitrogen is added to fertilizer. In general, nitrogen enters a watershed that has little human activity as rain In rivers with little human activity, total nitrogen is around 0.12 mg/l with nitrate representing about 85% of the nitrogen.	<0.52 -0.63 mg/L X	X	x	х
Total Kjeldahl Nitrogen	The total concentration of nitrogen in a sample present as ammonia or bound in organic compounds.		х	x	
Ammonia	Ammonia occurs as a result of organic decomposition and is common in sewage, fertilizers. Form of nitrogen most readily taken up by plants. Can be toxic to fish at low concentrations. Ammonia will often be converted to nitrate in the presence of oxygen.	<0.05 -0.076 mg/L ~ X	Х	х	

	Sampling Periods 1,3	Periods ^{1,2}			
Constituent 4	What is It and Why is It Important?	Spring Runoff	Summer Low Flow	Fall Turn-over	First Major Rain
Total Phosphorous	Measure of the total amount of phosphorus – both biologically available and bound in organic compounds. Phosphorous results from normal decomposition of organic mater. In lakes, an N:P ratio greater than 16:1 indicates that phosphorous, rather than nitrogen, is limiting for production, which is typical in oligotrophic lakes in the Sierras.	<0.05 mg/L X	X	, X	х
Dissolved Ortho- phosphate	Biologically available phosphorus – in the form of PO ₄ .	<0.2 mg/L	X	Х	÷
Total Alkalinity (measured as CaCO ₂)	Measures water's ability to neutralize acids (buffer capacity), and reduces toxicity of some metals. Levels above 400-600 mg/l may be harmful to crops and humans. Alkalinity of natural waters is due primarily to the presence of hydroxides, bicarbonates, carbonates and occasionally borates, silicates and phosphates.	<5-26 mg/L X	X	X	X
Calcium	Essential macronutrient, 5th most common element, and considered nontoxic. It is present in most natural systems introduced as water passes over calcium-rich formations. Contributes considerable to hardness (Sierra waters typically have low hardness) and may range from 0 to 200 mg/l naturally.	0.5-19 mg/L X	X	X	x
Chloride	Unlike free chlorine (which is toxic), the chloride ion is required by cells during photosynthesis.	0.32-0.92 mg/L X	х		
Magnesium	Essential macronutrient, primary component in photosynthetic pigments, 8th most common element. It is present in most natural systems, contributes considerable to hardness (Sierra waters typically have low hardness) and may range from 0 to several hundred mg/l naturally.	<0.5-0.63 mg/L X	x	x	
Potassium	Unlike terrestrial plants, K plays a minor role in plant growth. Needed in for enzyme activation.	<0,5 mg/L X	х		
Sodium	Sixth most abundant element and present in most waters naturally. Has low toxicity.	<0.5-2.1 mg/L X	х		
Sulfate		1.1-1.4 mg/L X	х	Х	
Aluminum (Al)	Third most abundant metal in earth's crust. Not known to have a nutritional function in organisms. Enters system from leaching over aluminum-containing soils. Toxic in high concentrations and acidic (pH below 6.2) environments. In these cases, aluminum precipitates on fish gills, interfering with the transfer of calcium and sodium between blood and water. Also, in high concentrations may reduce primary productivity in lakes by combining with phosphates.	<0.05-0.130 mg/L as total Al X	X	X	х

			Sampling 1	Periods 1,3	
Constituent ⁴	What is It and Why is It Important?	Spring Runoff	Summer Low Flow	Fall Turn-over	First Major Rain
Arsenic (As)	Known carcinogen and a poison. Low levels occur naturally in surface water. Higher temperatures increase toxicity. Not affected by hardness.	<0.005 mg/L as total As X	х	X	
Barium (Ba)	16th most common element in nature, but only trace amounts usually found in surface waters.	<0.02 mg/L as total Ba X	X	X	
Cadmium (Cd)	Toxic metal and known human carcinogen, with bioaccumaltive properties carcinogen, with bioaccumaltive properties. Drinking water in the US has a mean of about 0.008 mg/l of total cadmium.	<0.0005 mg/L as total Cd X	X	X	
Copper (Cu)	Essential macronutrient for plants and animals. Generally considered to have low concentrations in oligotrophic aquatic systems of granitic alpine likes, which can limit photosynthesis. High concentrations of copper (usually as CuSO ₄) are used to control algal blooms. Bradford et al (1968) ¹⁰ reported a mean concentration of 0.0012 mg/l of total Cu in 170 high Sierra lakes in CA. Exposure to levels less than 10 ppb (1µ/L) cause chronic toxicity symptoms in freshwater fish.	<0.001 mg/L as total Cu X	x	х	
Cyanide (CN)	Lethal toxin. Although not a metal, can combine to from alkali metal salts, and immobile metallocyanide. Often associated with gold extraction. At pH of 9.2 or less >90% occurs as free cyanide (CN or HCN). In general, cyanide has low persistance in surface waters (although may persist in groundwater). Cyanide has shown to adversely affect fish reproduction affecting the viability of the eggs. Not considered to be carcinogenic nor does it bioaccumulate.		x	x	
Iron (Fe)	Essential macronutrient for plants and animals. Enters watercourses from leaching of natural deposits in the form of relatively insoluble crystalines (i.e iron pyrite), particulates (organic matter or hydroxides) and soluble iron (ferric and ferrous iron). Hydrated ferric iron forms insoluable compounds and is deposited on sediments as a rust-colored layer called ocher (Fe(OH) ₂). Bradford et al (1968) ⁵ reported a mean concentration of 0.0013 mg/l of total Fe in 170 high Sierra lakes in CA.	<0.1-0.120 mg/L as total Fe X	х	х	
Lead (Pb)	Toxic element that accumulates in animals, and toxicity is influenced by pH, alkalinity and hardness. Concentrations in natural waters usually less than 0.02 mg/l.	<0.0005-0.0028 mg/L as total Pb X	х	х	х

			Sampling I	Periods 1,2	
Constituent 4	What is It and Why is It Important?	Spring Runoff	Summer Low Flow	Fall Turn-over	First Major Rain
Manganese (Mn)	Necessary macronutrient for plants and animals (needed as a cofactor in several enzyme systems, including those involved in respiration and nitrogen metabolism), and normally present in surface waters in various oxidation states as soluble complexes or suspended particles. Rarely exceeds 1 mg/l in natural waters. Bradford et al(1968) 5 reported a mean concentration of 0.0003 mg/l of total Mn in 170 high Sierra lakes in CA.	<.0.01-0.016 mg/L as total Mn	X	X	
Mercury (Hg)	Organic and inorganic salts very toxic and mercury naturally associated with Sierra soils. Mercury bioaccumulation within the aquatic food chain has potential to cause risks to piscivorous wildlife and human health.	<0.0002 mg/L as total Hg	X	X	X
Nickel (Ni)	Seldom found in natural waters, but may enter due to leaching of nickel-bearing geologic formations, such as serpentine rock and soils, which are common in Sierras. Toxicity related to hardness and may be mobilized with low pH conditions.	<0.01 mg/L as total Ni X	х		
Selenium (Se)	Essential macronutrient but may affect normal embryo development and be toxic in higher concentrations.	<0.002 -0.004 mg/L as total Se	Х	х	e e
Silver (Ag)	Considered one of the most toxic heavy metal ions, but because monovalent silver ion is easily reduced it is not readily accessible to living organisms in the natural environment. Toxicity increases with hardness.	<0.0005 mg/L as total Ag	х	х	X
Zinc (Zn)	Essential macronutrient element for human growth and many aquatic organisms. Bradford et al (1968) ⁵ reported a mean concentration of 0.0015 mg/l of total Zn in 170 high Sierra lakes in CA.	<0.02 mg/L as total Zn	х	Х	
Total Coliform Bacteria	Non-pathogenic microorganisms used in testing water to indicate the presence of pathogenic bacteria. This test is not recommended, as it will not provide any additional information over the fecal coliform or E. coli bacterial tests.			X	х
Fecal Coliform/E. coli Bacteria	A group of bacteria normally present in large numbers in the intestinal tracts of humans and other warm-blooded animals. Bacteria levels are of interest primarily during high recreational periods at local beaches, or during high runoff in areas with potential for inputs of untreated animal wastes. (USEPA tests have now shown E. coli to have better correlation with water contact and sickness.)	X ¹	х	х	x
Oil & Grease	Enters system from man.		х	х	Х

Assuming data gathered is not duplicative of El Dorado County's sampling efforts for three sites below Chili Bar Reservoir

ATTACHMENT 1 (continued)

			Sampling I	Periods 1,2	.,
Constituent ⁴	What is It and Why is It Important?	Spring Runoff	Summer Low Flow	Fall Turn-over	First Major Rain
МТВЕ	Methyl-tert-butyl ether used as a gas additive to make fuel burn more efficient. Is a possible carcinogen, and is being phased out in California.		X	, X	
Total Petroleum Hydrocarbon	Enters system from man.	<0.050 mg/L	Х	X	

Sampling Periods are defined as spring runoff (April/May), summer low flow (August/early September), fall turnover (October/ November), and first major rain (November/December).

Sampling strategies are defined by X's or numerically. "X" indicates those periods in which SMUD proposes to sample for this constituent. The numerical ranges represent actual values obtained during the June 10, 2002 sampling event at 10 water sampling sites: Gerle Creek below Loon Lake, SF Rubicon below Gerle Creek, SF Silver Creek below Ice House, Silver Creek below Junction Dam, Silver Creek below Camino Dam, SFAR above Camino Powerhouse, SFAR above Camino Powerhouse, Brush Creek below Brush Creek Reservoir, SFAR below Slab Creek Dam, and SFAR & Whiterock Powerhouse Discharge.

All constituents designated with * are identified as In situ sampling parameters, and shall be included as standard sampling parameters at all triage sampling stations plus the designated bypass reach stations identified as WQ Monitoring Stations 9, 13, and 36 on Table 2.

Water quality sampling locations for relicensing of Sacramento Municipal Utility District's Upper American River Project and Pacific Gas and Electric Company's Chili Bar Project.

	Triage Sampling	Contingency S	ampling
Water Quality Monitoring Station	Take & Analyze *	Take with Triage Samples & Analyze if Problem	Take & Analyze if Problem
Rubicon River inflow to Rubicon Resv.		X	
R-1. Rubicon Resv. mid-lake	1/3 depth / Epilimnion+hypolimnion		
2. Rubicon R. outflow from Rubicon Resv.	x	1 The same we	
3. Rubicon R. upstream of Rubicon Springs			X
3a. Fox Lake reach flow from Rubicon Resv		X	
4. Highland inflow to Rockbound Resv.		X	
R-2. Rockbound Lake mid-resv.	1/3 depth / Epilimnion+hypolimnion		
5. Rubicon outflow from Rockbound Lk.	X	· /····	
R-3. Buck Island Resv. mid-lake	1/3 depth / Epilimnion+hypolimnion		
6. Little Rubicon outflow from Buck Is. Lk.	X		
R-4a Loon Lake Resv. near dam	1/3 depth / Epilimnion+hypolimnion		
R-4b Loon Lk. mid-resv. in west body	1/3 depth / Epilimnion+hypolimnion		
R-4c Loon Lk. upper resv. N-E body	1/3 depth /		
	Epilimnion+hypolimnion		
7. Gerle Ck. outflow from Loon Lake	X		
Jerrett Ck. upstream of Gerle Ck. con.			Х
Gerle Ck. downstream of Jerret confl.	In situ <i>only</i>		Х
10. Barts/Dellar Ck. upstream of Gerle Ck.			X
11. Gerie Ck. dwnstrm of Barts/Dellar conf.			X
12. Rocky Basin Ck. upstream of Gerle			Х
13. Gerle Ck. dwnstrm of Rocky Basin conf	In situ only		X
14. Gerle Ck. inflow to Gerle Ck. Resv. R-5. Gerle Ck. Reservoir mid-resv.	<u> </u>	·	
	1/3 depth / Epilimnion+hypolimnion		
15. Gerle Ck outflow from Gerle Ck Resv	Х		
16. Gerle Ck Canal inflow to Robb's Frby	, х		
17. S.F. Rubicon inflow to Robb's Foreb 18. S.F. Rubicon upstream of Gerle Ck con.		Х	
 S.F. Rubicon upstream of Gerle Ck con. S.F. Rubicon dwnstrm of Gerle Ck con. 		·	X
20 GE D.L. CD L. D.	-		X
21. Tells Ck. upstrm of Union Valley Resv.	X	v	
22. Big Silver Ck. upstrm of Union Valley	<u> </u>	X X	
23. Jones Fk Silver Ck inflow to Un.V. Res	· · · · · · · · · · · · · · · · · · ·	X	
R-6a Union Valley Resv. near dam	1/3 depth / Epilimnion+hypolimnion		
R-6b Union Valley Resv. mid-resv.	1/3 depth / Epilimnion+hypolimnion		
R-6c Union Valley Resv. (Robb's Pk. PH tailrace zone)	1/3 depth / Epilimnion+hypolimnion		

	Triage Sampling	Contingency S	ampline
Water Quality Monitoring Station	Take & Analyze *	Take with Triage Samples & Analyze if Problem	Take & Analyze if Problem
R-6d Union Valley Resv. Jones Fork arma			
	1/3 depth /		
24 S.E. Cilver Clr. synstem of Lea House Dec	Epilimnion+hypolimnion	7	
24. S.F. Silver Ck, upstrm of Ice House Res. R-7a Ice House Reservoir near dam		X	
R-7a ICE HOUSE RESERVOIT HEAT HAIT	1/3 depth /	,	
	Epilimnion+hypolimnion	y. 1.	
R-7b Ice House Reservoir mid-resy.		The same	
	1/3 depth /		
	Epilimnion+hypolimnion		•
R-7c Ice House Reservoir upper lake body	1/3 depth /		
	Epilimnion+hypolimnion		
25. S.F. Silver Ck. outflow from Ice House	X		
26a. S.F. Silver 3-4 mi, dwnstr of IH Resv	In situ only		X
26b. S.F. Silver upstrm of Big Hill Cnyn.		· ,	<u> </u>
27. S.F. Silver Ck inflow to Junction Resv.	X		<u> </u>
28. Little Silver Ck. inflow to Junction Resv		X	
R-8 Junction Reservoir, mid-resv btwn arms	119 3-41		*
	1/3 depth / Epilimnion+hypolimnion		
29. Silver Ck. outflow from Junction Resv.	Epilimnion+nypolimnion X		
30. Onion Ck. upstream of Silver Creek	A.		x
31. Silver Ck dwnstrm of Onion Ck confl.			x
32. Silver Ck. inflow to Camino Resv.	X		^
33. Jay Bird Ck, inflow to Camino Resv.	1	X	
R-9. Camino Reservoir mid-resv.			
	1/3 depth /		
	Epilimnion+hypolimnion	*	
34. Silver Ck. outflow from Camino Resv.	X		
36. Silver Ck. Immediately upstrm of SFAR	X		i .
37. SFAR upstream of Silver Ck confluence			X
38. SFAR upstream of Camino Powerhouse		X	
39. Brush Ck, inflow to Brush Ck. Resv.		Х	
R-10. Brush Creek Resv. mid-resv. site	1		
	1/3 depth /		
40. P1-Cl49	Epilimnion+hypolimnion		
40. Brush Ck, outflow from Brush Ck Resv. 41. SFAR dwnstrm of Camino Powerhouse	X		
R-11a Slab Creek Reservoir mid-resv. site			
K-11a Siau Creek Reservoir iniu-resv. Site	1/3 depth /	·	
•	Epilimnion+hypolimnion		
R-11b Slab Creek Resv. upper-resv. site			·
	1/3 depth /	· ·	
<u> </u>	Epilimnion+hypolimnion		
42. Slab Ck, inflow to Slab Ck. Reservoir		X	
43. SFAR outflow from Slab Ck Resv – upstream of	X		
Iowa- Brushy Cnyn Ck confl.			I
44. SFAR between Slab Ck Res & Rock Ck			X
45. Rock Creek upstream of SFAR confl.	***		X X
Rock Creek upstream of SFAR confl. SFAR downstream of Rock Ck. confl.	X		
45. Rock Creek upstream of SFAR confl. 46. SFAR downstream of Rock Ck. confl. 47. SFAR downstream of White Rock P.H.	X X		
Rock Creek upstream of SFAR confl. SFAR downstream of Rock Ck. confl.	X 1/3 depth /		
45. Rock Creek upstream of SFAR confl. 46. SFAR downstream of Rock Ck. confl. 47. SFAR downstream of White Rock P.H. R-12a Chili Bar Reservoir near dam	Х		
45. Rock Creek upstream of SFAR confl. 46. SFAR downstream of Rock Ck. confl. 47. SFAR downstream of White Rock P.H.	X 1/3 depth / Epilimnion+hypolimnion	,	
45. Rock Creek upstream of SFAR confl. 46. SFAR downstream of Rock Ck. confl. 47. SFAR downstream of White Rock P.H. R-12a Chili Bar Reservoir near dam	X 1/3 depth / Epilimnion+hypolimnion 1/3 depth /		
45. Rock Creek upstream of SFAR confl. 46. SFAR downstream of Rock Ck. confl. 47. SFAR downstream of White Rock P.H. R-12a Chili Bar Reservoir near dam R-12b Chili Bar Reservoir mid-resv. site	X 1/3 depth / Epilimnion+hypolimnion 1/3 depth / Epilimnion+hypolimnion		
45. Rock Creek upstream of SFAR confl. 46. SFAR downstream of Rock Ck. confl. 47. SFAR downstream of White Rock P.H. R-12a Chili Bar Reservoir near dam	X 1/3 depth / Epilimnion+hypolimnion 1/3 depth /		

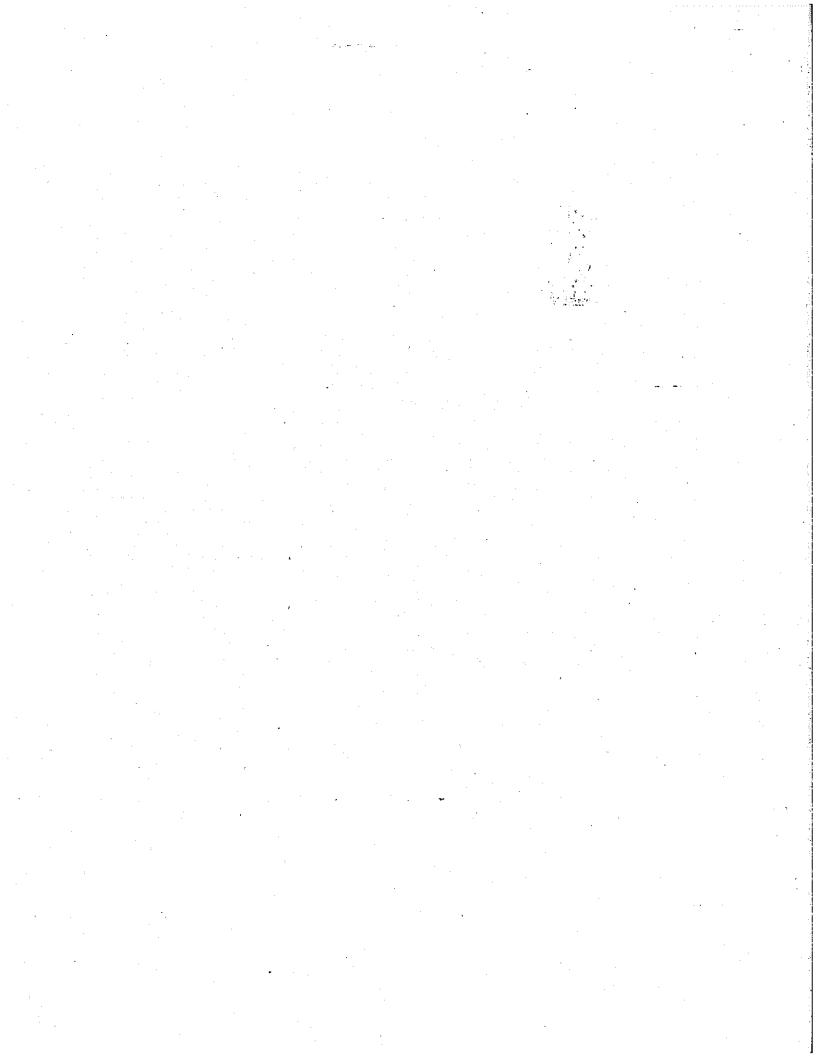
	Triage Sampling	Contingency S	ampling
Water Quality Monitoring Station	Take & Analyze *	Take with Triage Samples & Analyze if Problem	Take & Analyze if Problem
51. SFAR dwnstrm of Greenwood Creek, near ex- USGS 11445500	х	-	
52. SFAR upstream of Weber Creek	*		Y
53. Weber Ck upstream of confl. w/ SFAR		į	X
54. SFAR below Weber Creek confluence in a riverine environment	X		

^{*} During periods of reservoir stratification, samples will be collected within the upper epilimnion layer and also in the hypolimnion layer a few feet above the reservoir bottom. When reservoir profile is mixed, samples will be collected at a point below the water surface equivalent to approximately one-third the total water column depth.

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Water Quality Analytical Method and Maximum Lab Holding Times

Constituent	Method	Hold time
Al	EPA 200.8 and 245.7	. 180 d
As	EPA 200.8 and 245.7	180 d
Ba	EPA 200.8 and 245.7	180 d
Cd	EPA 200.8 and 245.7	180 d
Cu	EPA 200.8 and 245.7	180 d
Fe	EPA 200.8 and 245.7	/ 180 d
Pb	EPA 200.8 and 245.7	180 d
Mn	EPA 200.8 and 245.7	180 d
Hg	EPA 245.7	28 d
Ni	EPA 200.8 and 245.7	180 d
Se	EPA 200.8 and 245.7	180 d
Ag	EPA 200.8 and 245.7	180 d
Zn	EPA 200.8 and 245.7	180 d
Oil and grease	EPA 1664	28 d
MTBE	SW 5030B/SW 83260B	14 d
ТРН	SW 5030B/SW 8021B/9015	14 d
Nitrate-Nitrite	EPA 300.0	
Ammonia as N	EPA 350.0 EPA 350.2	48 h
TKN as N	EPA 351.3	28 d
Total phosphorous	EPA 365.2	28 d
Orthophosphate	EPA 365.3	28 d
TOC	EPA 415.1	48 h
Hardness	EPA 130.2	28 d
Total Alkalinity	EPA 310.1	180 d
TSS	EPA 160.2	14 d
TDS	EPA 160.2 EPA 160.1	7 d
Cn	EPA 100.1 EPA 335.2	7 d
Ca	EPA 333.2 EPA 200.7	1,80 d
Mg	EPA 200.7 EPA 200.7	180 d
K	EPA 200.7 EPA 200.7	180 d
Na Na	EPA 200.7 EPA 200.7	180 d
chloride	EPA 200.7 EPA 200.7	180 d
sulfate	EPA 200.7 EPA 200.7	28 d
Surate	EPA 200./	180 d
coliform/E. coli (screening)	9221/9222 D or as available	24 h
fecal coliform (regulatory)	9222	24 h



Glossary of Analytical Laboratory Terminology and Reporting Terms

Method Detection Limit (MDL):

Is a measure of the method sensitivity. The MDL is the lowest concentration that can be detected by an instrument with correction for the effects of sample matrix and method-specific parameters such as sample preparation. It is the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero, as defined in 40 CFR 136, Appendix B, revised as of May 14, 1999.

Criterion Quantitation Limit (CQL):

The level of analytical resolution needed to assess regulatory compliance. The CQL is the lowest amount of an analyte in a sample that can be quantitatively determined with suitable precision and accuracy. The desired criterion quantitation levels for the analysis of sampled constituents shall be set at 10% below the controlling (or lowest) applicable Basin Plan water quality objective, or California and National Toxics Rule criteria.

Practical Quantitation Limit (PQL):

The concentration that can be reliably measured within specified limits and accuracy during routine laboratory operating conditions. It is typically determined by a combination of the IDL (Instrument Detection Limit—the lowest the instrument is capable of seeing with specified confidence limits) and the lowest calibration standard used. The calibration level is selected (usually greater than the IDL) based upon the needs of the specific batch of samples being run (e.g. based on the levels set by the client, etc.)

Reporting Limit (RL):

The reporting limit for the laboratory. This is the lowest quantifiable (vs. estimated) concentration that the laboratory can determine, must be greater than or equal to the PQL, and is chosen based on client's needs and/or quality control. Ideally, the RL should be equal to or lower than the desired minimum CQL to meet the purposes of this monitoring. Due to the low limits that are required for the water quality analysis, the reporting limit will be set as low as possible (i.e. the same as the practical quantitation limit). If it is not possible for the laboratory to reliably measure concentrations at the desired minimum CQL for a given constituent using the most sensitive commonly available methodology, estimated concentrations will be reported down to the MDL (even though these estimated concentrations are below the "reporting limit" – See *Procedures for Reporting Results*.)

Procedures for Reporting Results:

- 1. Sample results greater than or equal to the RL shall be reported as measured by the laboratory (i.e., the measured chemical concentration in the sample).
- 2. Sample results less than the RL, but greater than or equal to the laboratory's MDL, shall be reported as "Detected, but Not Quantified" or DNQ. If the laboratory is unable to reliably measure concentrations at the desired minimum CQL for a given constituent (thus the RL is above the controlling applicable water quality objective or criteria), the estimated chemical concentration of the sample shall also be reported.
- 3. Sample results less than the laboratory's MDL shall be reported as "Not Detected," or ND.

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Location of Fecal Coliform / E. coli Sampling Stations

Site#	"5 in 30"	"Seasonal"	For "5 in 30" and "Seasonal" sampling efforts Location/Notes
UARP			
	X ²		Buck Island reservoir near dam at dispersed camping site
	· · · · · · · · · · · · · · · · · · ·	X	Buck Island reservoir north shore beach
		X	Loon Lake reservoir near-shore at northeast end at Pleasant
			campground
	X	·	Loon Lake reservoir at Ellis Creek inflow on west side of creek
		X	Loon Lake reservoir near-shore west of main dam
	Х		Gerle Creek below Loon Lake gaging station at USFS property boundary (marked)
	X	+.	Loon Lake reservoir near-shore near Northshore campground in
			dispersed recreation area between RV CG and main dam
		X	Loon Lake near-shore east of Loon Lake campground
		X	Gerle Creek below Ice House Road bridge below dispersed area
	X		Gerle Creek reservoir near-shore between dock and day use area
		X	Union Valley reservoir near-shore at Wench Creek campground
		X	Union Valley reservoir near-shore at Yellowjacket campground
	X		Union Valley reservoir near-shore at Camino Cove
	X	X	Union Valley reservoir near-shore at Fashoda beach (Peninsula)
	X		Union Valley reservoir near-shore at Jones Fork campground
		X	Union Valley reservoir near-shore at West Point boat ramp
	X		Jones Fork Silver Creek at Ice House road
	X		Big Silver Creek at bike bridge
		X	Ice House reservoir at inflow of South Fork Silver creek
	X		Ice House reservoir near-shore at east end near day use area
		X	Ice House reservoir near-shore at peninsula cove on north shore mid- length of reservoir ("Highland" area)
	X		Ice House reservoir near-shore near youth camp boat storage area
		X	Ice House reservoir near-shore west of boat launch area
	Х		Ice House reservoir near-shore on west end of reservoir near day use area
		X	South Fork Silver Creek downstream of SMUD gaging station
		X	Junction reservoir near boat ramp dispersed camp area
		X	Camino reservoir near road
		X	Brush Creek boat ramp
	Х		Brush Creek boat ramp
		X	Slab Creek reservoir boat ramp
	X		SFAR below bridge at Camino powerhouse
Chili Bar d	am and reservoir		1 21 TAX 00104 0110ge at Caninto powerhouse
	1	X	Chili Bar reservoir near shoreline (dam road)
	х	X	SFAR at gage station below dam
		* 7	1 of the at Eagle station below dain

² "5 in 30" surveys will be performed to include Labor Day for upper elevation waterways; "5 in 30" surveys will be done during July 4 weekend for lower elevation waterways.

The downstream reach		
X		SFAR downstream of Miner's cabin (in coordination with BLM)
X		SFAR at County Park parking lot
X	X	SFAR downstream of Greenwood Creek
. X		SFAR upstream of Hastings Creek (in coordination with BLM)
X		SFAR downstream of Weber Creek (in coordination with BLM)
	X	SFAR upstream of Salmon Falls (above inundation zone)

SMUD UARP WATER QUALITY MONITORING PROJECT FISH TISSUE STUDY

RESERVIORS SAMPLED	•	DAYS EFFORT
Slab Creek/Chili Bar		2
Union Valley/Ice House		1
Gerle/Loon Lake		2

TARGET SPECIES - Indigenous predator, either trout or bass.

Brown and Brook Trout are not hatchery raised and are good target species. Rainbows are often planted as catchables, but some occur as wild fish. The hatchery fish are identified by their fins. Wild fish have sharp edges on their fins, the rays are straight and the fins often have white tips. Hatchery raised fish have deformed fins, the rays are crooked and the edges are often fleshy. Hatchery trout that have survived several years after planting show regeneration of their fins. The new growth shows some characteristics of wild trout fins.

Bass (Largemouth or Smallmouth)
Probably only smallmouth bass will be found in these reservoirs and lakes.

Six fish of similar size (25% rule) will be collected from each reservoir and composited into one sample.

COLLECTION METHODS

The preferred method of collecting fish samples is electro fishing from a boat. This is effective along the shoreline and especially near the mouths of inflowing streams. To do this, there must be boat launching available and the water must have enough dissolved solids to carry an electric current. Alternatively, a gill net will be fished overnight.

Sampling should be completed by September 1, 2003.

SAMPLE PREPARATION

Fish will be dissected and homogenized using clean techniques according to DFG Fish and Wildlife Water Pollution Control Laboratory standard operating procedures. Liver and fillets will be composited and homogenized separately.

SAMPLE ANALYSIS - \$386/sample or composite

Fish tissues will be analyzed for trace elements by ICP-MS at the DFG Marine Pollution Studies Laboratory at Moss Landing.

<u>Tissue</u>

Trace Elements Analyzed

Fillets

mercury, selenium, arsenic, cadmium, nickel

Liver

silver, chromium, copper, lead, zinc

ESTIMATED COMPLETION DATE - November 1, 2003

MERCURY IN TISSUE

1.0 SCOPE AND APPLICATION

This is an atomic spectroscopy method for the determination of mercury in fish tissue.

2.0 SUMMARY OF METHOD

2.1 Fish tissue is digested with concentrated nitric acid.

The mercury ions are reduced to elemental mercury with stannous chloride. The mercury vapor is analyzed by cold vapor atomic spectroscopy.

2.2 The detection limit for this method is approximately $0.02 \mu g/g$ wet weight for a 1.0 g sample.

3.0 INTERFERENCES

Certain volatile organic materials that absorb at this wavelength (253.7 nm) may cause interference. A preliminary run without reagents should determine if this type of interference is present. Chlorine causes severe interference.

4.0 APPARATUS AND MATERIALS

- 4.1 Digestion tubes: polypropylene digestion vessels Cat. # SC499 or SC500 from Environmental Express
- 4.2 Ribbed watch glass Cat. # SC505 from Environmental Express
- 4.3 50 ml Rohre/Tube Cat. # 62.559 from Sarstedt (Aktiengesellschaft & Co)
- 4.4 15 ml Rohre/Tube Cat. # 62.554.01 from Sarstedt (Aktiengesellschaft & Co)
- 4.5 Filter papers Cat. # 1004 090 from Whatman, for use if filtration is needed for the sample
- 4.6 Hot block for metals digestions Cat. # SC154 from Environmental Express
- 4.7 Teflon spatulas
- 4.8 Mercury lamp
- 4.9 Compressed argon
- 4.10 Atomic Spectroscopy Perkin Elmer equipped with: flow injection mercury system 400 (FIMS 400), data system, programmable autosampler (AS-90 series).

5.0 REAGENTS

5.1 Type II water

- 5.2 Stannous chloride dihydrate, crystal ("Baker Analyzed" JT3980-11), 25%SnCl₂*2H₂O in 20% HCl. Dissolve 50g SnCl₂*2H₂O in 40 ml HCl. Mix and allow to stand until SnCl₂*2H₂O has dissolved and solution is clear. Bring to volume (200 ml) with type II water. PREPARE FRESH DAILY. (approximately 800 ml needed for the set of 32 tubes of sample, 5 tubes for standard curve and quality control)
- 5.3 Mercury Standard Solution (stock) J.T. Baker, 1000 ppm
- Mercury Standard Solution (intermediate) 1.0 ppm in 1.0% nitric acid.

 Partially fill a 1000 ml volumetric flask with Type II water. Add 1 ml of 1000 ppm HgCl₂. Bring to volume (1000 ml) with Type II water.
- Mercury calibration standards: Partially fill each volumetric flask with Type
 II water, add the appropriate volume of 1.0 ppm HgCl₂ standard and 40 ml concentrated nitric acid and bring to volume with Type II water. As solution cools, it will be necessary to add water to keep level at 100 ml. Mix well.

0.0010 ppm: Add 0.10 ml of 1.0 ppm HgCl₂ 0.0050 ppm: Add 0.50 ml of 1.0 ppm HgCl₂ 0.0100 ppm: Add 1.00 ml of 1.0 ppm HgCl₂ 0.0250 ppm: Add 2.50 ml of 1.0 ppm HgCl₂ 0.0005 ppm: Add 5.00 ml of 0.01 ppm HgCl₂

- 5.6 Mercury Check Standard and Spike Standard: E.M. Science, 1000ppm.
- 5.7 Intermediate solution (A): 100.0 ppm in 1.0% nitric acid. Partially fill a 100 ml volumetric flask with Type II water. Add 10.0 ml of 1000 ppm HgCl₂. Bring to volume with Type II water.
- 5.8 Intermediate solution (B): 1.0 ppm in 1.0% nitric acid. Partially fill a 100 ml volumetric flask with Type II water. Add 1.0 ml of solution (A). Bring to volume with Type II water.
- 5.9 Check Standard: 0.010 ppm in 40% nitric acid. Partially fill a 100 ml volumetric flask with Type II water. Add 1.0 ml of solution (B). Bring to volume with Type II water.
- 5.10 Hydrochloric acid (HCl), concentrated, reagent grade.
- 5.11 Nitric acid (HNO₃), concentrated, reagent grade.

6.0 SAMPLE COLLECTION, PRESERVATION, AND HANDLING

- 6.1 All samples must have been collected using a sampling plan that addresses the considerations discussed in this manual.
- 6.2 All sample containers must be prewashed with detergents, acids, and Type II water. Plastic and glass containers are both suitable.
- 6.3 Nonaqueous samples shall be frozen, when possible, and analyzed as soon as possible.

7.0 PROCEDURE FOR SAMPLE PREPARATION

Preparation of samples:

- 7.1 With each set of analyses, prepare 2 method blanks, 2 standard reference materials (~ 0.25 g dry tissue Dorm 2 or NBS 1566a), 2 matrix spike, 2 laboratory control spike, and one duplicate for every 10 samples.
- 7.2 Samples with equal weight of water added: Place 2.0 ± 0.5 g into clean digestion tube.
- 7.3 Samples without added water: Place 1.0 ± 0.5 g into clean digestion tube.
- 7.4 Add 10 ml concentrated nitric acid and let stand overnight.
- 7.5 The next day, digest samples in a programmable hot block. The parameters for heating are as follows:

Ramp: 5°C/min.

Set temperature: 105-108°C.

Hold: 2 1/2 hours

- 7.6 Allow the tubes to cool, then add Type Π water to the calibration mark (25ml). Vortex tubes to mix well.
- 7.7 Moisture Determination, if required
 - Number an aluminum weighing dish to correspond to the sample beaker number.
 - 2. Weigh the aluminum weighing dish and record its weight.
 - 3. Tare the aluminum weighing dish.
 - 4. Weigh \sim 3g (minimum 1g) tissue and record the weight.
 - 5. Place moisture samples in a 70°C oven for 48 hours.
 - 6. After cooling samples, weigh and record the dry weights.

Percent Moisture Calculation

(Dry sample weight
plus aluminum dish) - (Aluminum dish weight)

1 - ______x 100

(Wet sample weight) X (F)

F = the added water factor = 0.6666 when added water equals one half of the sample weight (i.e. flesh samples - Selenium Verification Program)

0.5 when added water equals the sample weight (i.e. flesh samples - Toxic Substance Monitoring Program) 1 when water was not added to the sample (i.e. liver and sediment samples)

8.0 ANALYTICAL PROCEDURE

- 8.1 Prepare reagents:
 - 8.1.1 25% SnCl₂ (see Section 5.2)
 - 8.1.2 Rinse water -3.0% HCl (Prepare 1000 ml: 30 ml HCl add to 970 ml Type II water)
 - 8.1.3 Reagent blank solution 40% HNO₃ (Prepare 500 ml: 200 ml HNO₃ add to 300 ml Type II water)

- 8.1.4 Calibration standards (see Section 5.5)
- 8.1.5 Check standard (see Section 5.9)
- 8.2 Transfer calibration standards and check standard to 50 ml Rohre/Tube, samples to 15 ml Rohre/Tube. The tubes should be numbered to correspond to sample number.
- 8.3 Operation of FIMS 400 and auto sampler
 - 8.3.1 Switch on the fume ventilation system, then the carrier gas supply (argon), adjust the pressure to 52 psig and finally switch on FIMS 400.
 - 8.3.2 Switch on the computer, printer and start Windows.
 - 8.3.3 In the Program Manager, double-click on AA 2.50.
 - 8.3.4 When "AA WinLab" appears, proceed as follows:
 - From the Tools menu, choose Open Workspace, or on the Toolbar, click on WkSpace.
 - Select hgtissue.fms, then click on OK. The window appears.
 - On the Toolbar, click on MethEd. Select Tissue Hg Test. All of the desired parameters have been entered for

Inst - Instrument parameters

Calib - Calibration parameters

FIAS - FIAS program instructions

Checks - Analytical checks for sample and calibration solutions

QC - Locations of quality control solutions and instructions for performing quality control procedures

Options - Remarks about the Method and options for saving and printing data

- Saving a method: From the File menu, choose Save As Method. A dialog appears.
 If you want to save the Method under a new name, type a name for the file, then
 press Enter or click on OK. To save the Method with the original name, press Enter
 or click on OK.
- Click on SampInfo on the Toolbar to enter the pertinent information (e.g. description, batch ID, analyst, the first sample ID should be at auto sampler location #9).
- Saving a sample information file: From the File menu, choose Save As ▶ Sample Infor File. A dialog appears. If you want to save the Sample Infor File under a new name, type a name for the file, then press Enter or click on OK.
- Printing the Autosampler Loading List: From the File menu, choose Print
 Autosampler Loading List.
- Select the name of the Results Data Set where you will save the results. If the data set exists, new data will be added to it.
- Select the Save Data check box if you want the results saved in the data set specified.
- Select the Print Log check if you want the results to be printed.

- Select the Off After Analysis: Lamp, Pumps check boxes to switch these items off at the end of the analysis.
- On the Automated Analysis window, check on "use Entire Sample Infor File" column.
- Click on the tab containing "Analyze": click on "Analyze all"after the reagents have been prepared, the signal has been optimized, the FIMS 400 flows have been set, the autosampler has been turn on, and the samples have been loaded.

8.3.5 To optimize the signal

- The absorbance values for each replicate should be similar. If the absorbance for the first replicate is higher than that for the subsequent ones, lengthen the Fill step on the FIAS page of the Method. If the absorbance of the first is replicate is lower, Lengthen the Prefill step.
- Ensure that the Read Delay (0 s) and Read Time (15 s) values are set correctly on the Inst page of the Method.
- Slight adjustments to the gas flow may improve sensitivity. If the peak maximum
 appears too early, slightly decrease the carrier gas flow. If the peak maximum
 appears too late, slightly increase the carrier gas flow.

Note: If the carrier gas flow is too high, the mercury vapor is dispersed too rapidly. If the flow is too low, mercury vaporflows into the cell too slowly. In both situations the signal and sensitivity are low. A flow in the range 40-70 ml/min is generally suitable.

• A slight decrease in the outflow from the gas/liquid separator may improve sensitivity.

Note: If the outflow from the gas/liquid separator is too high, mercury vapor may escape through the waste outlet. If the out-flow is too low, the fluid level may rise so high that moisture escapes into the sample transfer tube and the FIMS-cell. If liquid does enter the FIMS-cell, you must clean the cell as described in FIMS: Installation, Maintenance, System Description.

- Slight adjustments to the carrier and reductant flows may improve sensitivity.
- If the FIMS-cell is contaminated, e.g. because liquid has entered the cell, you must clean the cell as described in FIMS: Installation, Maintenance, System Description.

8.3.6 To set up the FIMS – 400

- The carrier gas stream has a large influence on sensitivity. If he flow is too high, the atom or hydride cloud is dispersed too
- rapidly. If the flow is too low, the resulting signal and sensitivity are lower. A flow
 of 50-100 mL/min for the carrier stream is suitable. If there is no gas flow, the
 automatic gas valve may be closed. To start the flow, in the FIAS Control window,
 click on Valve Fill/Inject.

- Place the inlets of the carrier pump tube (yellow/blue), reductant pump tube (red/red) and sampling tube (leading to the FIAS valve) in containers of deionized water.
- Swing the pump pressure levers over to press the pump tube magazines against the rollers.
- On the Toolbar, click on FIAS. Then, in the FIAS Control window:
- Click on Valve Fill/Inject to set the valve to the Fill position. Type 100 for Pump # 1 Speed, and type 120 for Pump # 2 Speed. Click on Pump # 1 and Pump # 2 to start the pumps.
- The flows should be checked before every run. When checking flows, only use P-2. P-1 is dry except when sample is being pumped. The carrier pump tube (yellow/blue) should have a flow of 9-11 ml/min; the reductant pump tube (red/red) should have a flow of 5-7 ml/min. It is recommended that the tubes be replaced after two runs and that they are reversed when they are run the 2 nd time.
- After setting the flows, position the reagents.
- For gas/liquid separator, put filter paper's shiny side up

8.3.7 Sample Changer

 Load the sample carousel with standards, reagent blank solution and samples. Set in place the rinse solution (MQ H₂O) at location 0.

8.3.8 Initiate the run

- On the Toolbar, click on Analyses, select Autozero signal to zero the instrument.
- To analyze all the solutions: In the Automated Analysis Control window, click on Analyze All. All the solutions will be analyzed. The calibration solutions will be analyzed first, immediately followed by the samples and any other solutions (QC, reslope etc.).

PRECAUTIONS:

Check that the drain tube is connected to the gas / liquid separator and freely drains into collection vessel. The end of the drain tube must not be submerged in liquid. The exhaust hood over the FIMS should be left on at all times.

8.3.9 Post run: Rinsing procedure after automatic analyses

- Place the inlets of the carrier and reagent (e.g. reductant, buffer) tubes in a container of deionized water.
- On the Toolbar, click on Auto.
- In the Automated Analysis Control window, click on Analyze page tab.
 - Click on Select Location. In the dialog box, select the Go to wash option, then click on OK.

- In the Automated Analysis Control window, click on Move Probe Up/Down to raise the sampling probe.
- Place a beaker with the first rinse solution in the wash location (usually location 0).
- Click on Move Probe Up/Down to lower the probe into the rinse solution.
- On the Toolbar, click on FIAS.
- In the FIAS Control window:
- Click on Valve Fill/Inject to turn the valve to the Fill position. (The position is shown in the Status display of the window.)
- In the FIAS Control window:
- Click on the Pump 1 and Pump 2 buttons to start the pump.
- In the FIAS Control window, click on Valve Fill/Inject a number of times while the
 pumps are running. This ensures that sample channel and the inside of the FIASvalve are rinsed effectively. Rinse the tubing with the de-ionized water for as long
 as necessary to remove all traces of the previous reagent.

8.3.10 Quality Control

- All quality control data should be maintained and available for easy reference or inspection.
- Calibration curves must be composed of a minimum of blank and three standards. After running the calibration curve, analyze an initial calibration blank and an initial calibration check standard (ICB, ICV). A continuing calibration blank (CCB) and a continuing calibration check standard (CCV) should be analyzed. This check standard is used to check the validity of the calibration curve standard and therefore should be obtained different vendor. The CCV result must be within 85-115% of the expected concentration. After the last sample in the run, a final FCB and FCV should be analyzed.
- Dilute samples if they are more concentrated than the highest standard.
- Analyze a minimum of two blanks per sample batch to determine if contamination or any memory effects occur.
- Analyze two standard reference material (SRMs) of a comparable matrix with each set of samples.
- Analyze on duplicate sample for every ten samples.
- Analyze a matrix spike (MS) and matrix spike duplicate (MSD) with each run.
- Analyze a laboratory control spike (LCS) and laboratory control spike duplicate with each run.

9.0 REFERENCES

- 9.1 Evans, S.J., Johnson, M.S., Leah, R.T. 1986. Determination of Mercury in Fish Tissue, a Rapid, Automated Technique for Routine Analysis. Varian Publication Number AA-60.
- 9.2 Perkin Elmer, Publication B3118.20. FIMS Flow Injection Mercury System. Setting Up and Performing Analyses. Atomic Spectroscopy.

Analyst:	Date:
Reviewed by:	Date:
Laboratory Director:	Date: